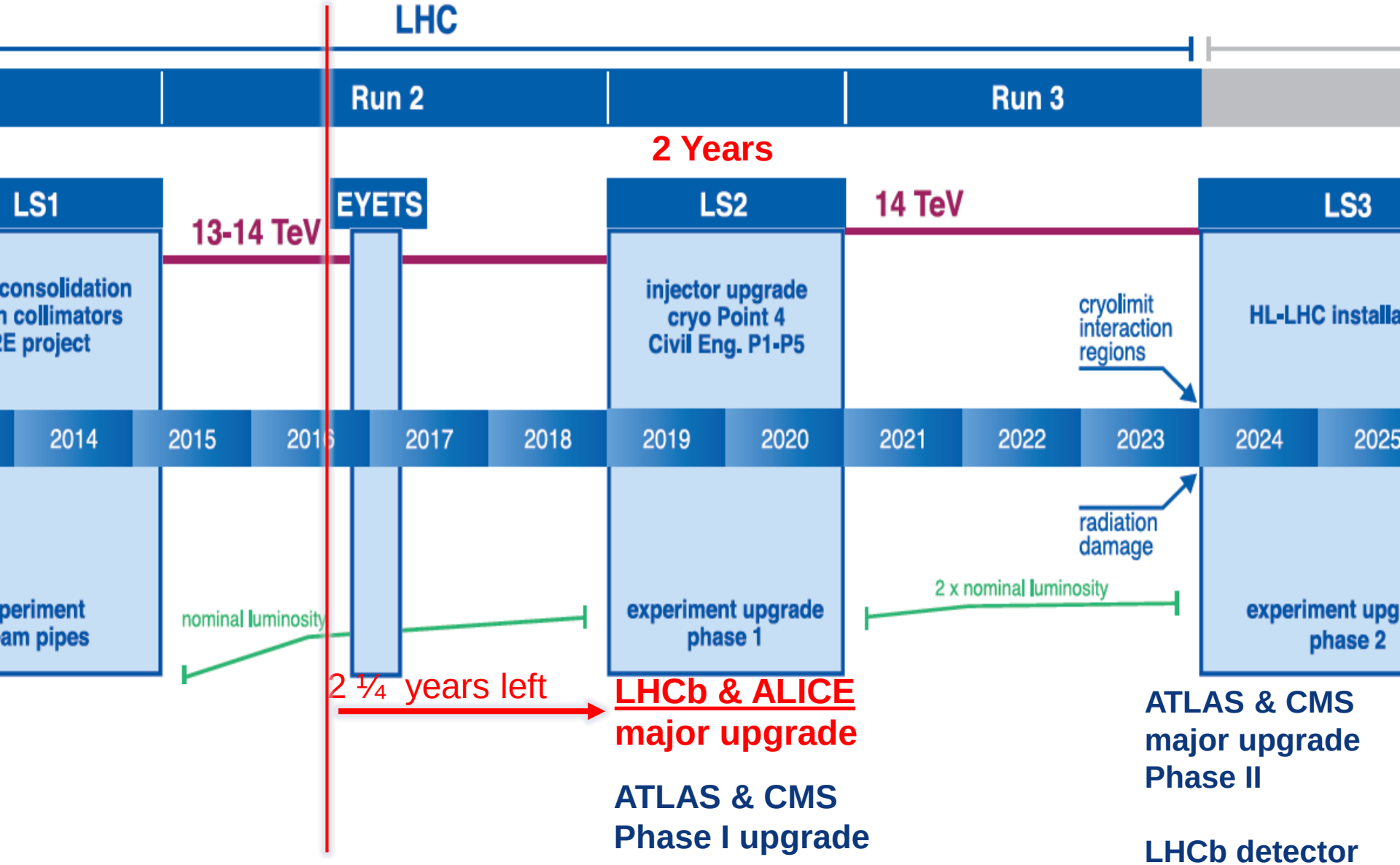
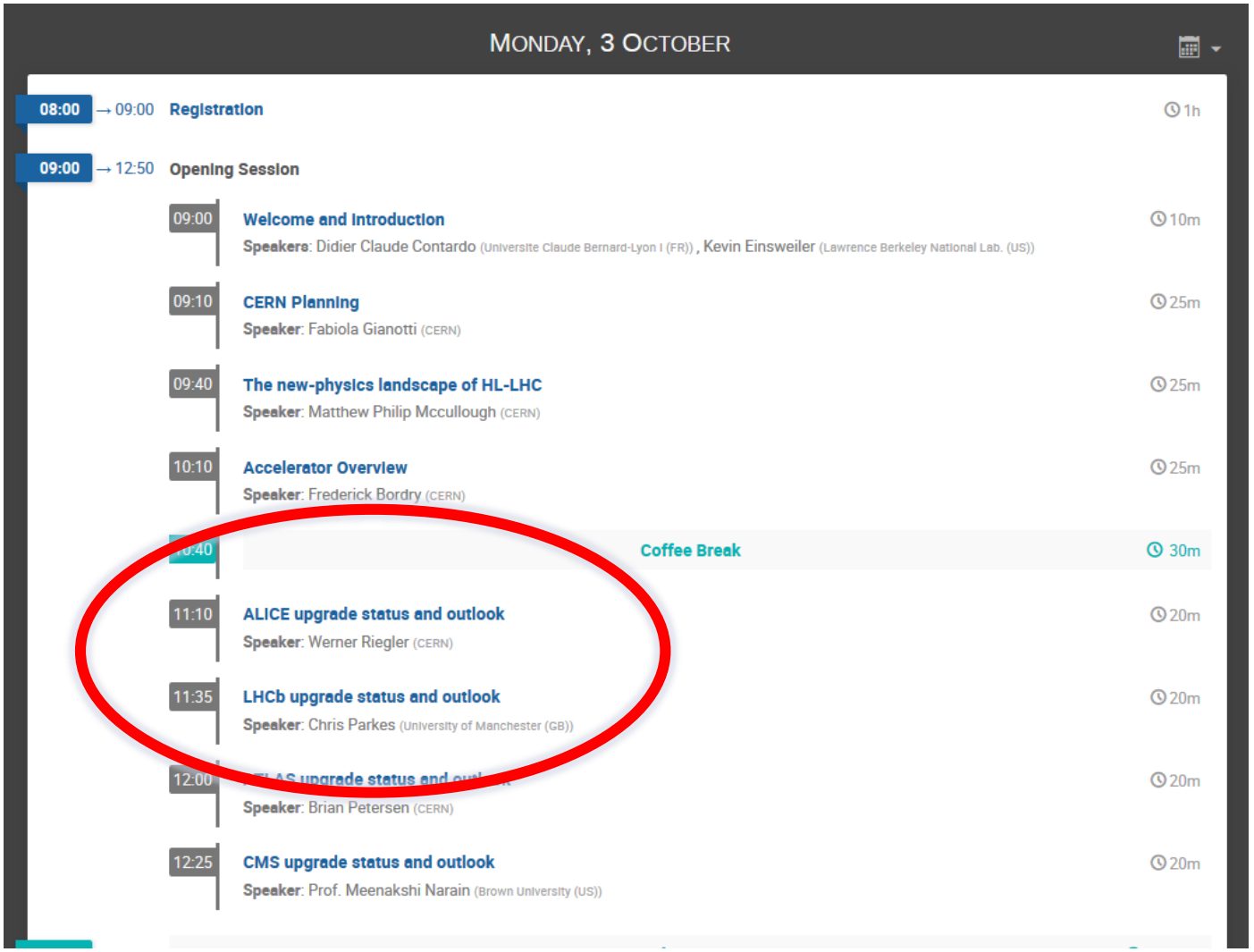
ALICE & LHCb LS2: PLANNING

Arturo Tauro
Eric Thomas

On behalf of ALICE and LHCb Collaborations


LHC
Run 2
Run 3
2 Years
LS1
EYETS
LS2
14 TeV
LS3
13-14 TeV
consolidation
n collimators
E project
injector upgrade
cryo Point 4
Civil Eng. P1-P5
cryolimit
interaction
regions
HL-LHC installa
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
radiation
damage
periment
am pipes
nominal luminosity
experiment upgrade
phase 1
2 x nominal luminosity
experiment upg
phase 2
2 ¼ years left
LHCb & ALICE
major upgrade
ATLAS & CMS
Phase I upgrade
ATLAS & CMS
major upgrade
Phase II
LHCb detector
consolidation &
improvement

ALICE & LHCb upgrades



MONDAY, 3 OCTOBER

08:00 → 09:00 **Registration** 1h

09:00 → 12:50 **Opening Session**

09:00 **Welcome and Introduction** 10m
Speakers: Didier Claude Contardo (Universite Claude Bernard-Lyon I (FR)) , Kevin Einsweiler (Lawrence Berkeley National Lab. (US))

09:10 **CERN Planning** 25m
Speaker: Fabiola Gianotti (CERN)

09:40 **The new-physics landscape of HL-LHC** 25m
Speaker: Matthew Philip Mccullough (CERN)

10:10 **Accelerator Overview** 25m
Speaker: Frederick Bordry (CERN)

10:40 **Coffee Break** 30m

11:10 **ALICE upgrade status and outlook** 20m
Speaker: Werner Riegler (CERN)

11:35 **LHCb upgrade status and outlook** 20m
Speaker: Chris Parkes (University of Manchester (GB))

12:00 **ATLAS upgrade status and outlook** 20m
Speaker: Brian Petersen (CERN)

12:25 **CMS upgrade status and outlook** 20m
Speaker: Prof. Meenakshi Narain (Brown University (US))

ALICE, LS2 upgrade scope

Motivation: Focus on high-precision measurements of rare probes at low p_T

- Cannot be selected by hardware trigger
- Need to record large sample of events

Goal: Pb-Pb recorded luminosity ≥ 10 nb^{-1}, (plus pp and p-Pb data)

- 8 x 10^{10} events to gain a factor 100 in statistics over the Run1+Run2 programme

Strategy:

- Read out all Pb-Pb interactions at a maximum rate of 50kHz (i.e. L = 6x10^{27} $cm^{-1}s^{-1}$) upon a minimum bias trigger
- Perform online data reduction based on reconstruction of clusters and tracks
- Improve vertexing and tracking at low p_T

  ➔ New Inner Tracking System (ITS)

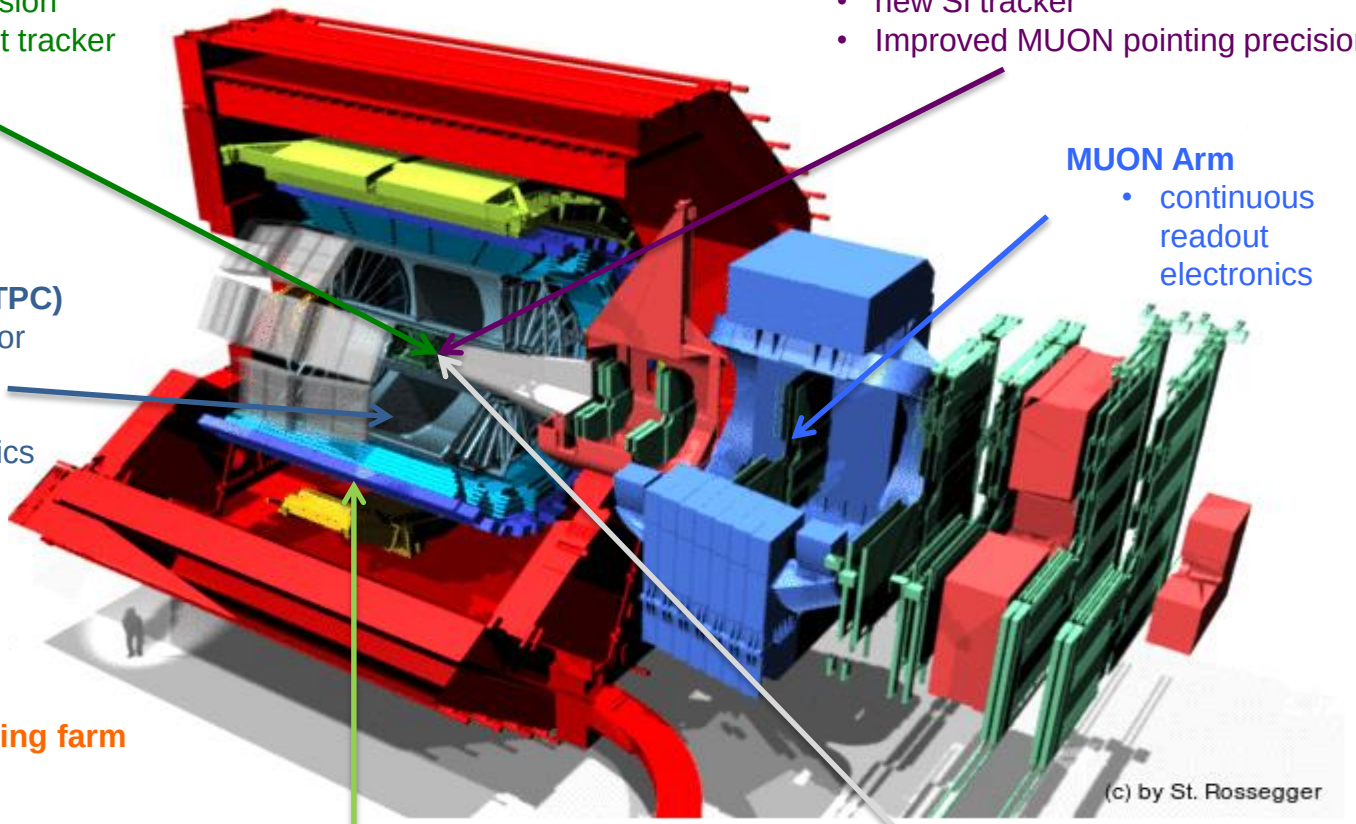
ALICE, LS2 upgrade scope

New Inner Tracking System (ITS)
- improved pointing precision
- less material → thinnest tracker at the LHC

Muon Forward Tracker (MFT)
- new Si tracker
- Improved MUON pointing precision

MUON Arm
- continuous readout electronics

Time Projection Chamber (TPC)
- new GEM technology for readout chambers
- continuous readout
- faster readout electronics



New Online/Offline computing farm (O2)
- new architecture
- on line tracking & data compression
- 50kHz PbPb event rate

TOF, TRD
- Faster readout

New Trigger Detectors (FIT)

The ALICE Upgrade, 5 TDRs

- Silicon Inner Tracking System (ITS) upgrade

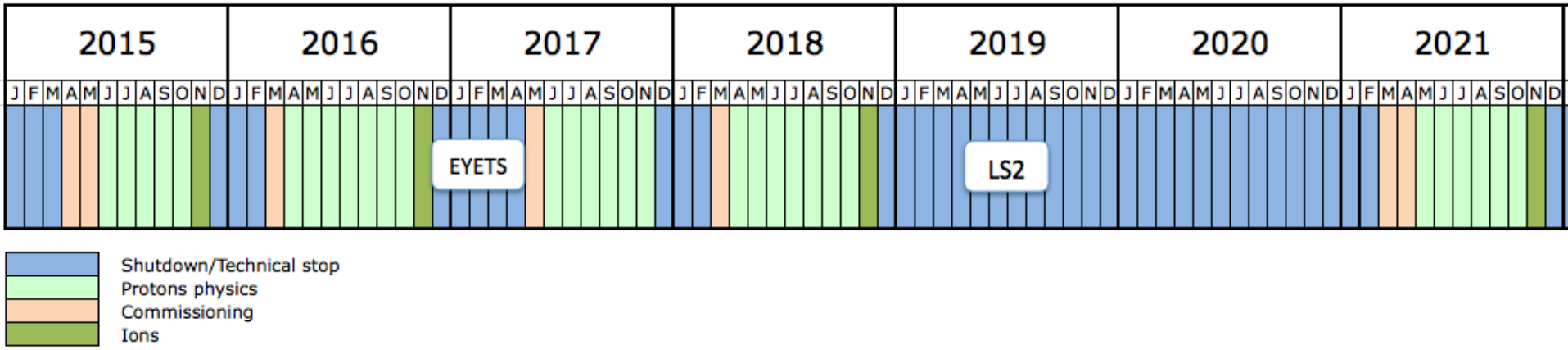
- Time Projection Chamber (TPC) readout chamber upgrade

- Muon Forward Tracker (MFT)

- Upgraded readout for all detectors to cope with the higher rate (SAMPA, CRU) Upgraded Central Trigger Processor
  Upgraded Fast Interaction Trigger (FIT) based on Quartz+MCP & Scintillator
  New Radiation requirements

- Upgraded Online-Offline (O2) system to handle the continuous readout at 50kHz PbPb collisions and reconstruction

The way to LS2

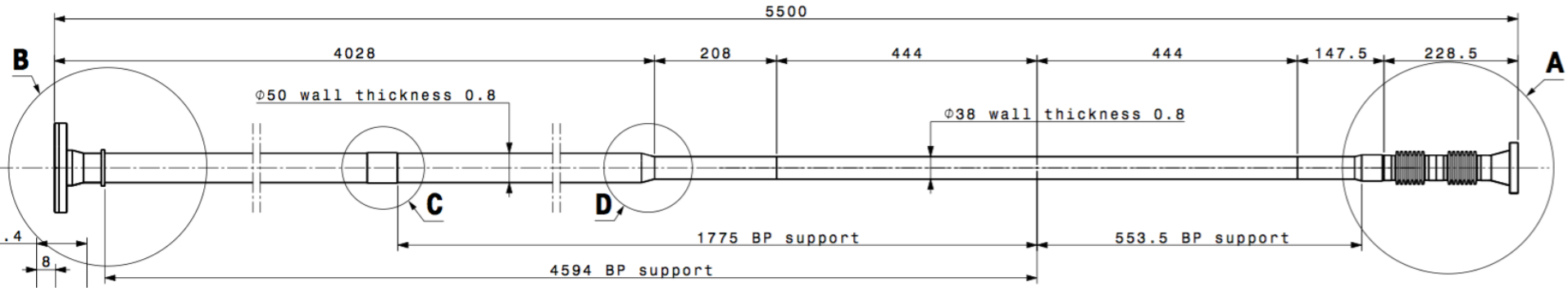


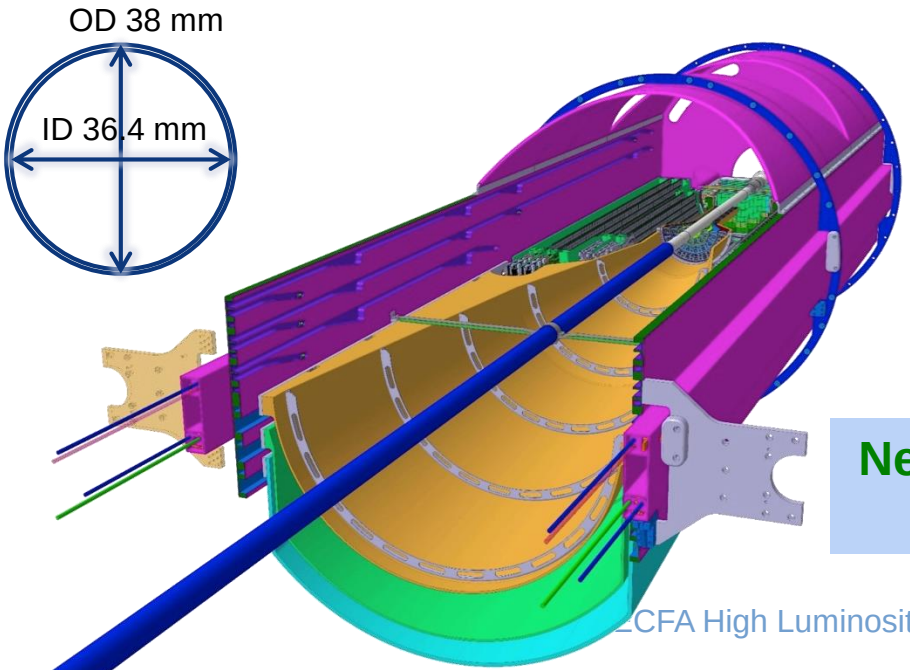
Preparation LS2

- LS2 preparations since end LS1
- LS2 duration: **102** working weeks (2 weeks in Dec 2018 and 2x50 weeks in 2019-20)

LS2 preparation

New central beampipe 1/2

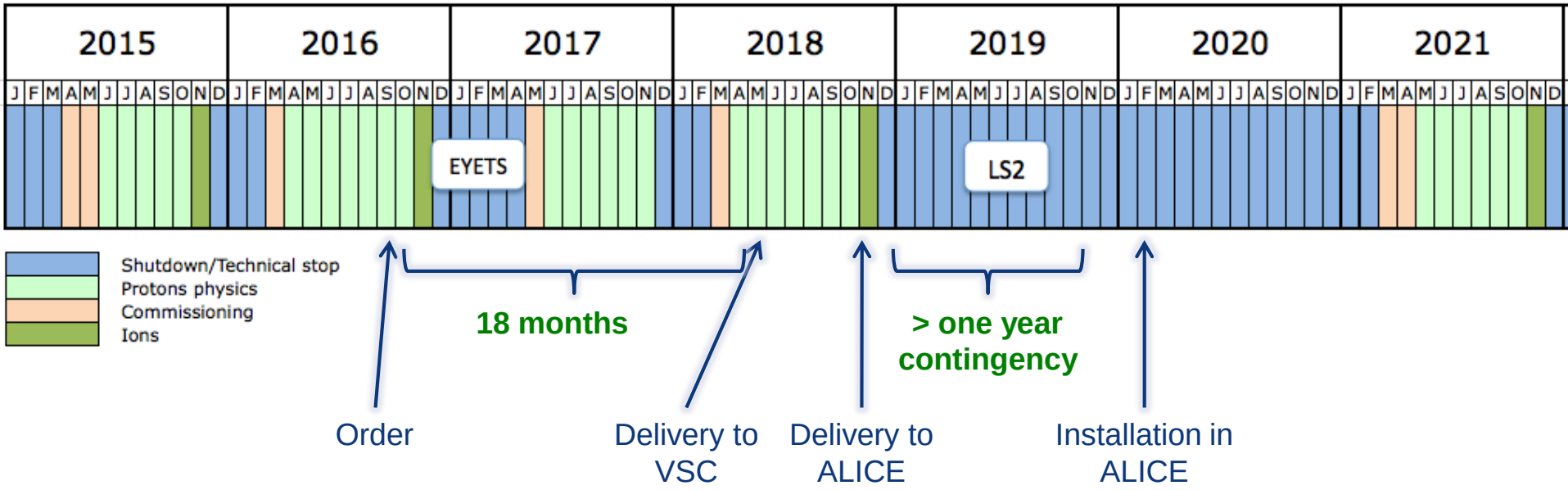




	Present beampipe	LS2 beampipe
Outer diameter	60mm	38mm (only central part)
Wall thickness	800um	800um
Length	482cm	550cm
Beryllium length	395cm	88.8cm
Bellows/flanges	SS	Al
Nb. of supports	3	3

New ALICE beampipe geometry officially approved in September 2014 LMC

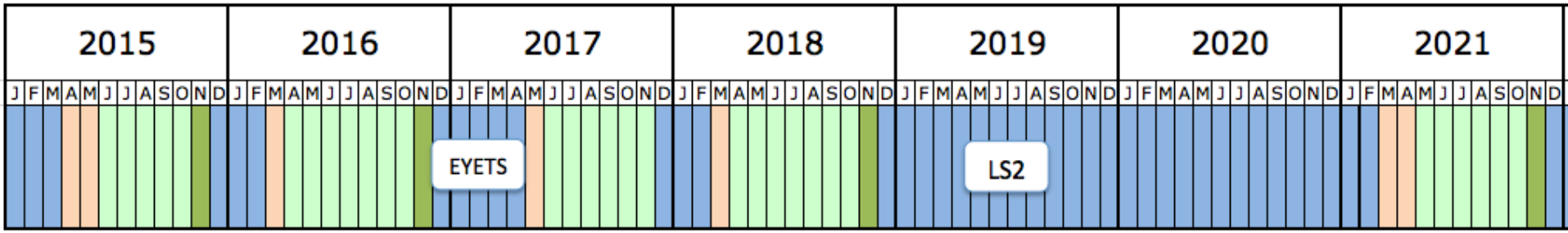
New central beampipe 2/2



Engineering design completed (now under approval)

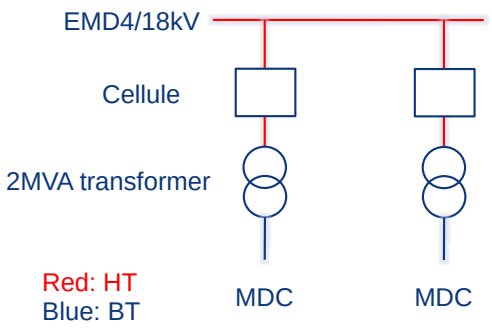
New O2 data centre at P2 (CR0)

If no data centre in Prevessin



Noise simulation done and put as requirement in ITT

CR0 location at P2

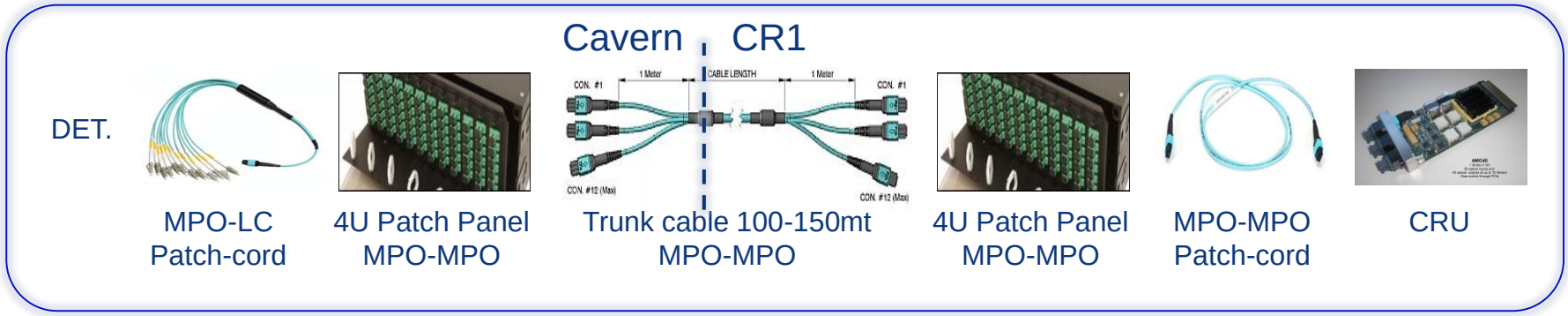


EL infrastructure

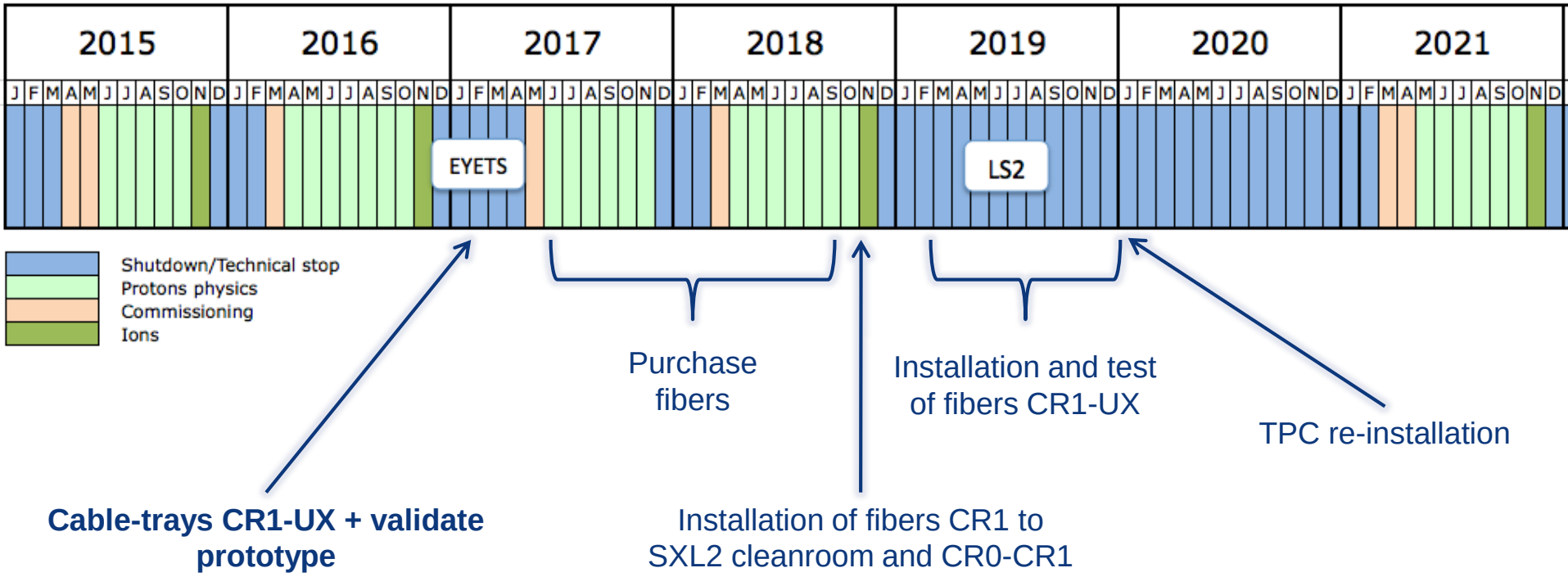
Example of MDC

Optical fibers 1/2

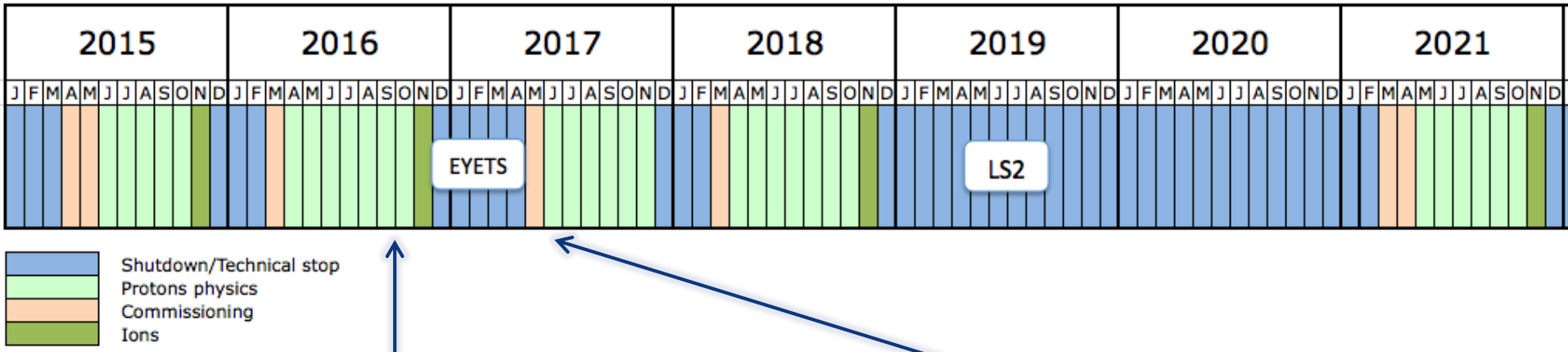
- 19’920 links, 145 trunk cables
- Architecture and technology selected: trunk cables 144F & MPO
- CERN offer received in May (EN-EL), other suppliers contacted
- Synergy with LHCb



Optical fibers 2/2

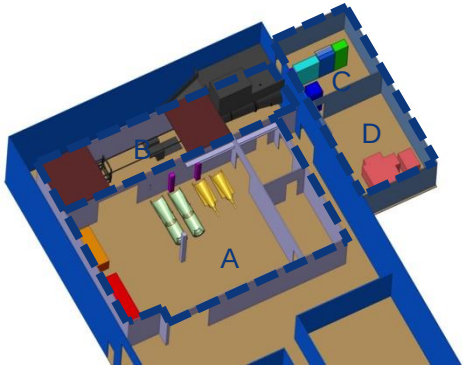


Cleanrooms



ITS cleanroom (B.167)

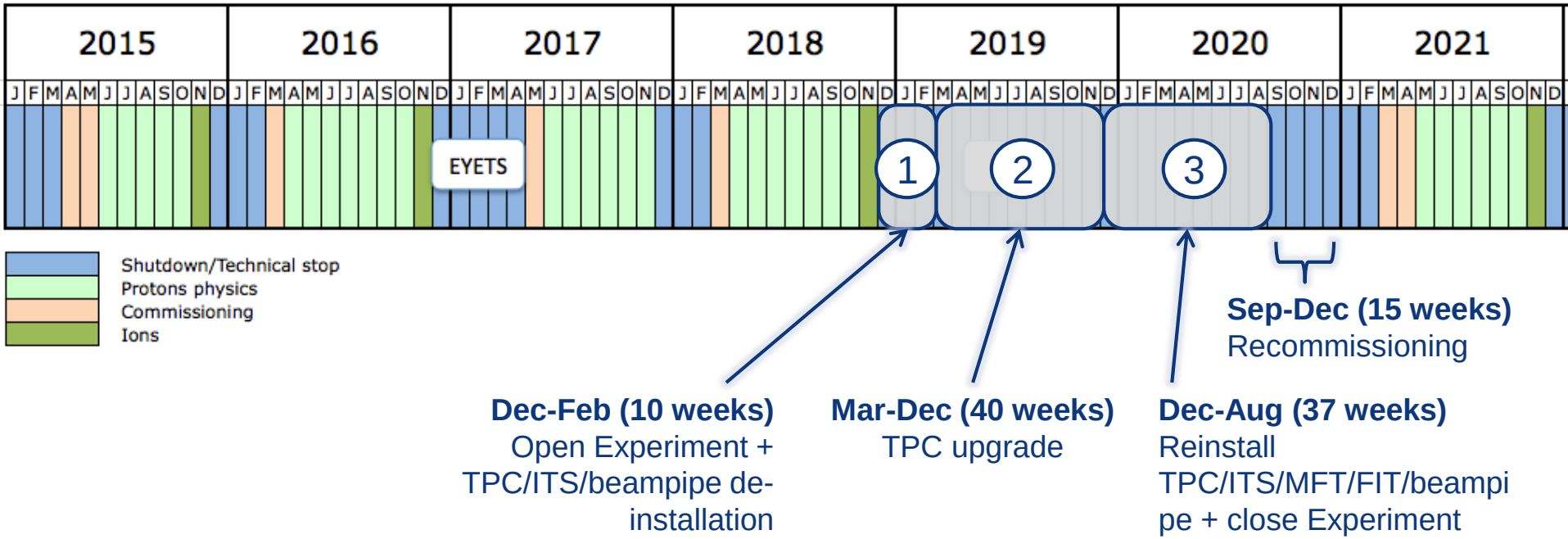
June 17': TPC cleanroom (ISO7)



Zone A (Assembly hall)
Zone B (Insertion Test)
Zone C (Counting Room& Cooling Plant)
Zone D (Control Room)

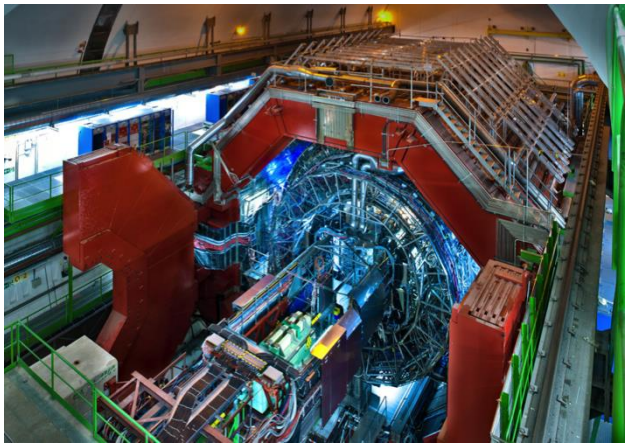
LS2 schedule

LS2 schedule



- One shift/day
- ‘Long’ days foreseen for transport tasks
- 24h/24 for few specific tasks (e.g. TPC RO tests)

① Open Experiment + TPC/ITS/beampipe de-installation



	Duration
Open cavern, L3 doors, comp.magnet/miniframe	3.5
Remove ITS & beampipe	5.5
Bring TPC to cleanroom	1
	Total: 10 weeks

Key resources: transport, P2 technicians, ITS and TPC groups

② TPC upgrade

	Duration
Remove electronics and services	5
Swap chambers	8
Survey and align chambers and end plates	3
Sealing, T sensor installation and leak test	4
Reinstall electronics	8
Readout test	7
Close sectors	1
Contingency	4
	Total: 40 weeks

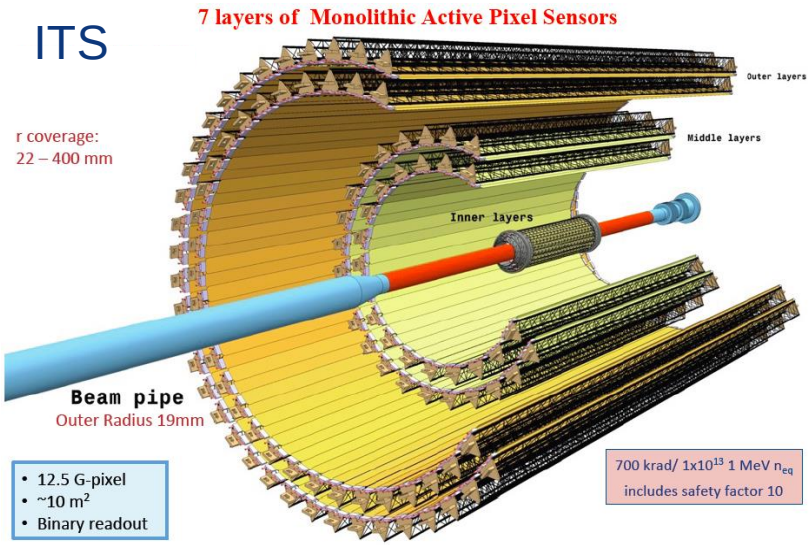
MWPC installation (photo 2006)

Yellow platform and installation jig

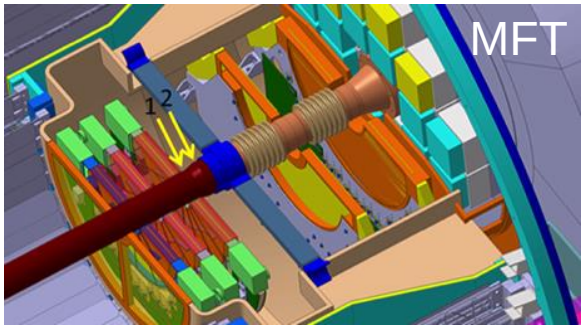
ISO5 tent

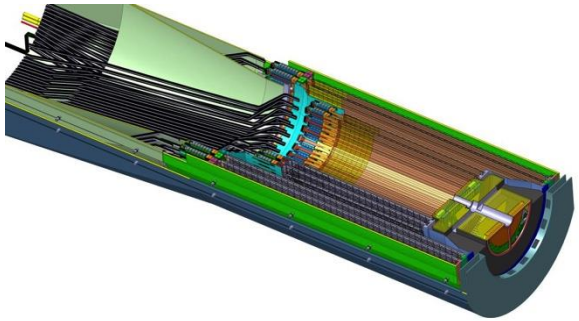
③ Reinstall TPC/ITS/MFT/FIT/beampipe + close Experiment

ALICE



	Duration
Reinstall TPC	3
Install ITS cage and new beampipe (incl.bakeout)	6
Reinstall miniframe	2
Install & commissioning MFT/FIT/ITS	18
MFT/FIT/ITS commissioning, close L3 doors and cavern	8
	Total: 37 weeks





Resources:
- ✓ Survey and transport
- ✓ P2 technicians
- ✓ TE-VSC (beampipe)

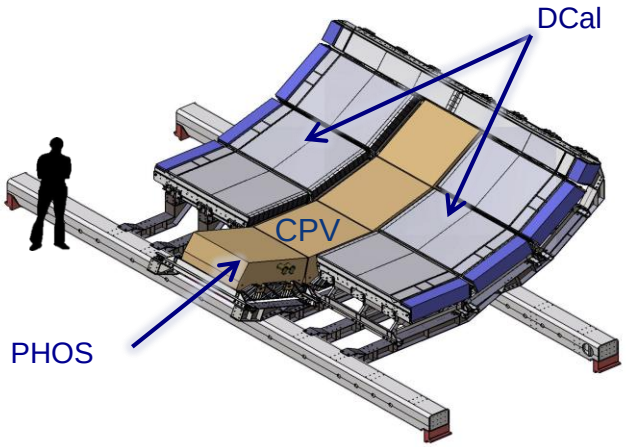
Other activities: detectors

In parallel to TPC upgrade

- Uninstall all 4 **PHOS** modules (fix FEE/TRU cards)
- Install 2 **CPV** modules

CPV installation (LS1)

These interventions imply to de-install also the 3 A-side DCal modules



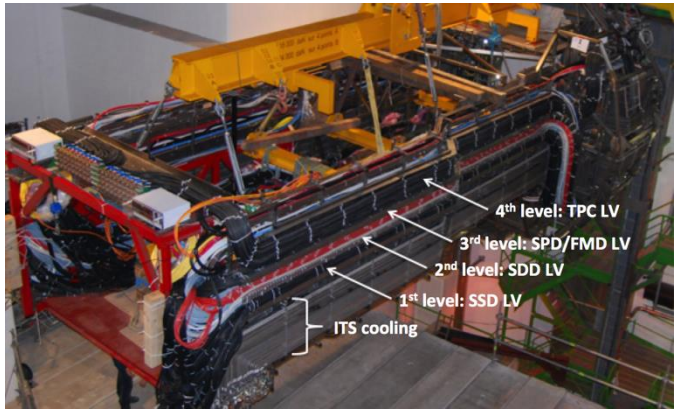
Other activities: services

In parallel to TPC upgrade

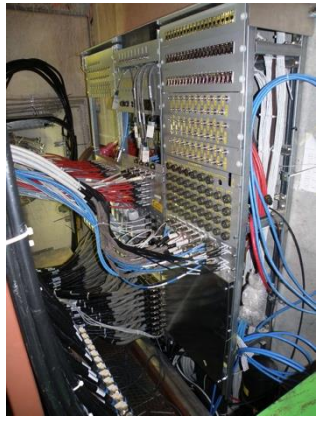
- Miniframe modification (PP0 and PP1)
- TPC/ITS/MFT/FIT cables
- Remove all cables from C-side (absorber area)
- New ITS/MFT water cooling plants (incl. new lines)
- New ITS ventilation duct
- Optical fibers

Key resources:

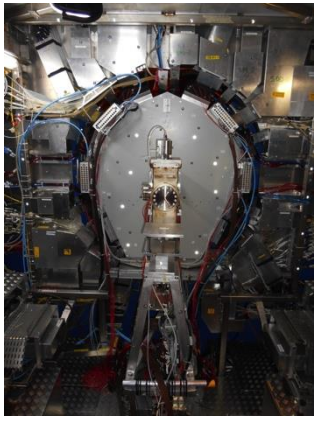
- ✓ Dedicated FSU team coordinated by ALICE TC
- ✓ Outside companies (e.g. new inox pipes)
- ✓ CERN cabling and scaffolding contracts (EL, EA)
- ✓ CERN EN-CV and EN-EL



Miniframe

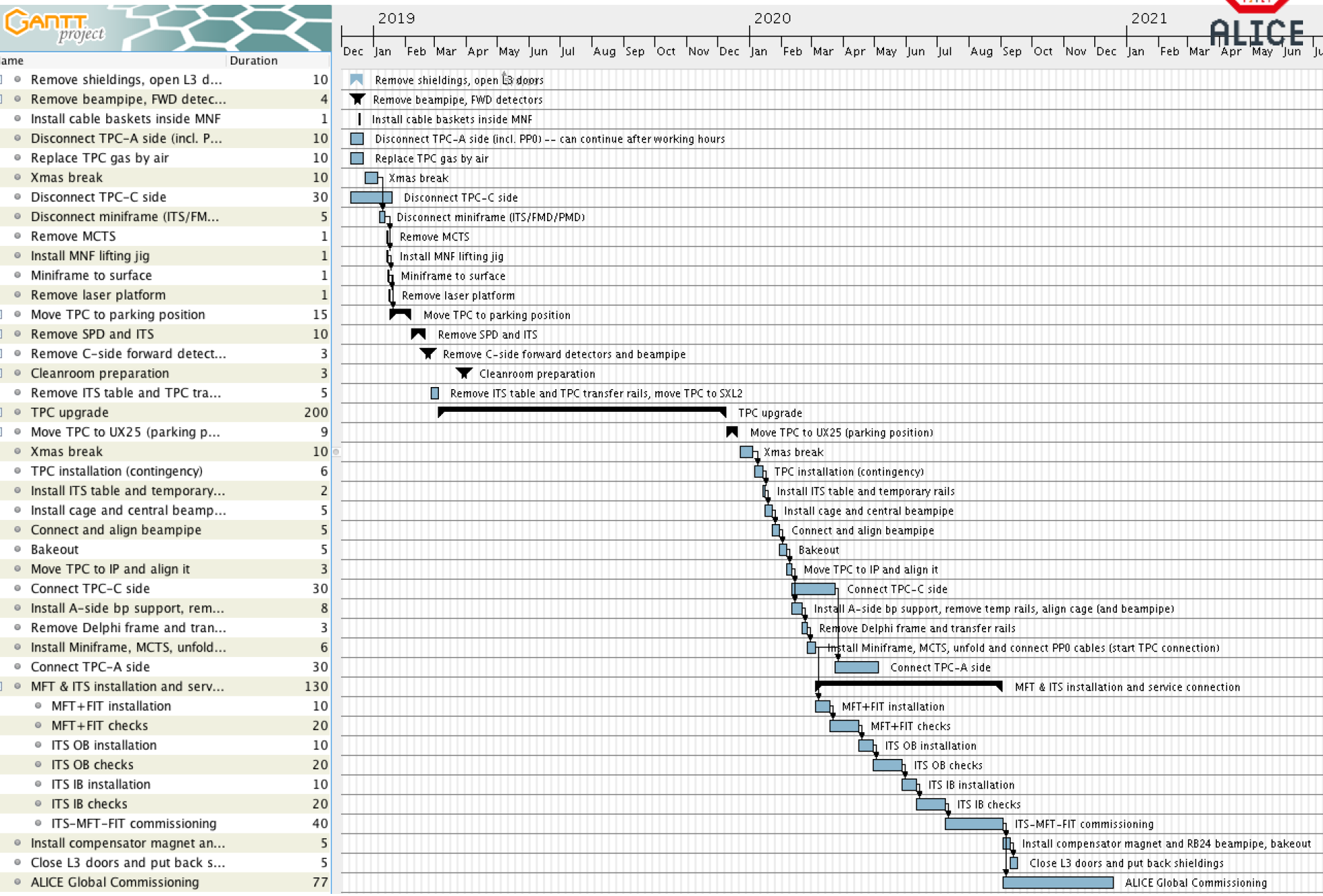


PP0



PP1

Detailed LS2 schedule

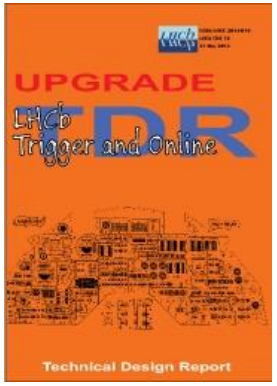


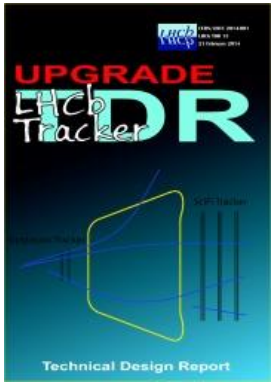
Conclusions

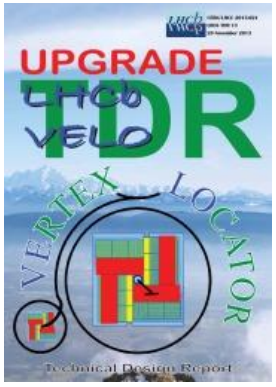
- **Well on track with LS2 preparations, as we started since end of LS1**
- **New beampipe will be ordered before end of the year. More than one year contingency before installation in ALICE**
- **Fibers will be installed in 2019, cable-trays in place already during upcoming EYETS**
- **LS2 schedule: TPC upgrade and ITS installation must be done in sequence for obvious reasons**
- **Dedicated FSU team for services modifications. Lot of support needed from CERN service groups (transport, survey and safety coordination) and cabling (and scaffolding) contracts!**
- **Four months foreseen for global ALICE re-commissioning at the end of LS2**

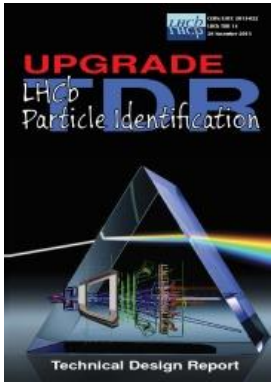
LHCb Upgrade parameters

LHCb is a high precision experiment devoted to the search for new physics beyond the Standard Model by studying CP violation and rare decays









Luminosity

Run2 **4 x 10^{32} cm^{-2} s^{-1}** (2 x nominal)

->Upgrade: **2 x 10^{33} cm^{-2} s^{-1}** (10 x nominal)

(Triggerless) Read-out

Run 2 **1 MHz**

→ Upgrade **40 MHz**

Increasing the read out to 40 MHz and the higher luminosity necessitates replacing all front-end electronics and the majority of detector systems.

To cope with the enormous increase of events to be evaluated, a larger CPU farm will be unavoidable. As space and cooling/power capacities are limited in the UX, a new 'Data Center' at the surface is in planning.

New detectors and r/o electronics

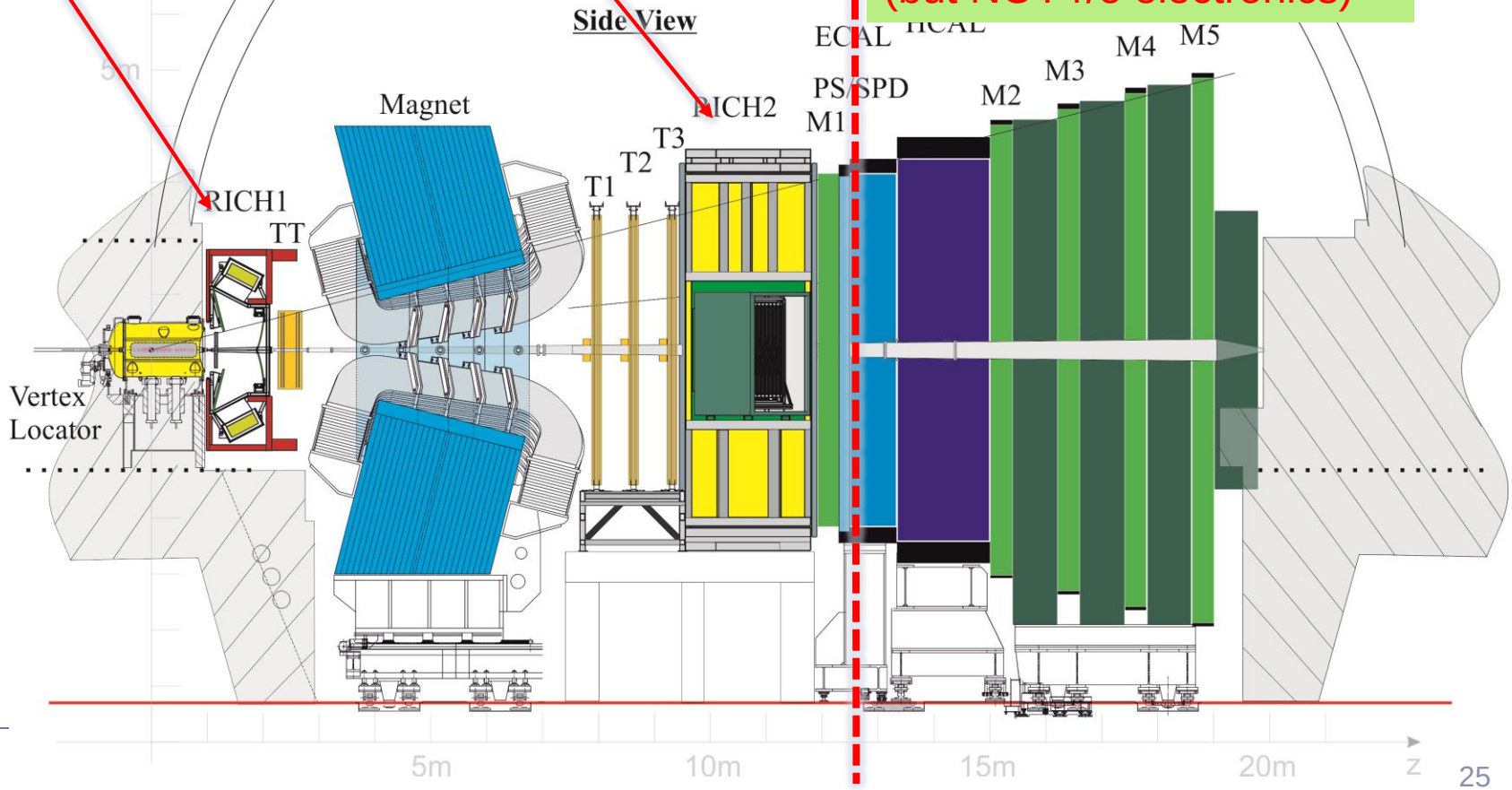
New r/o electronics

What stays in place?

RICH1 Shielding

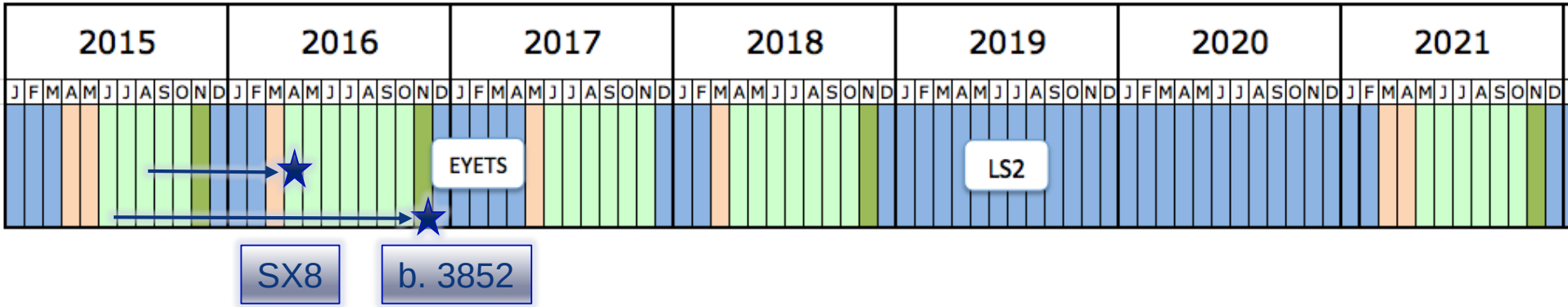
RICH2 box, mirrors

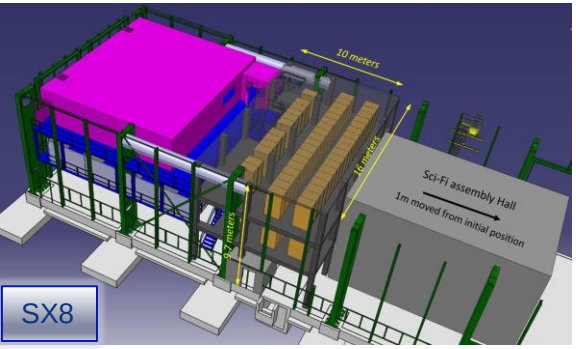
ECAL HCAL MUON
(but NOT r/o electronics)

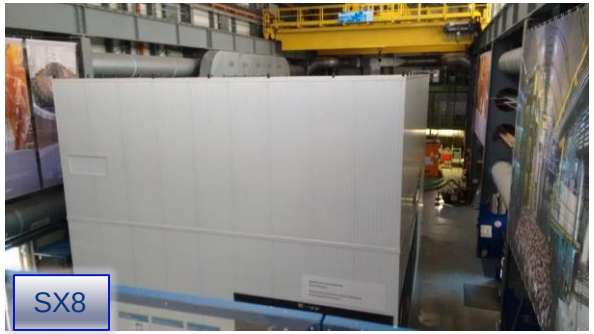


LS2 preparation

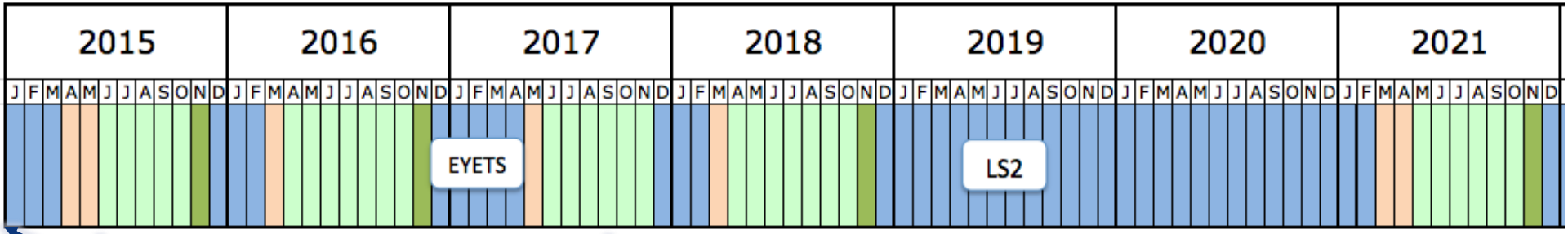
Detector assembling facilities at P8





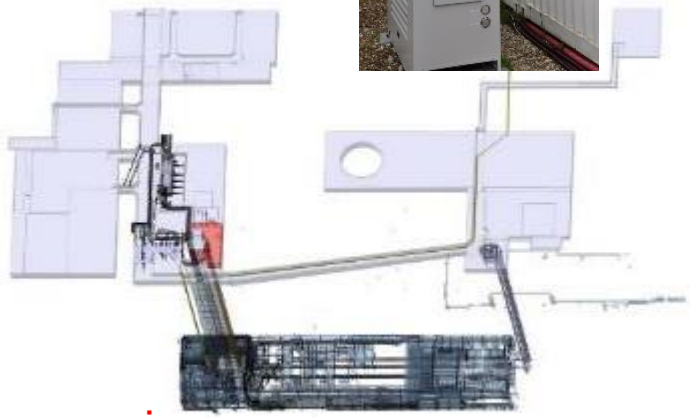


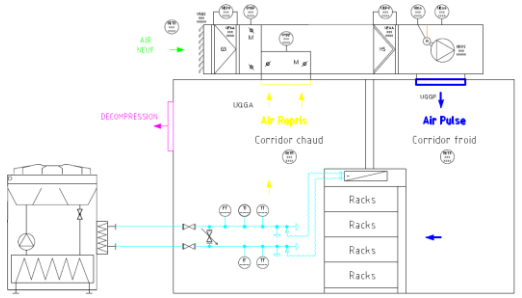
Data Centre (2MW) – Optical links (15k)



LS1:
1. Trays installed
2. Install 2x144 TEST fibres trunk cables FROM UX to SX
3. Validation of installation technique

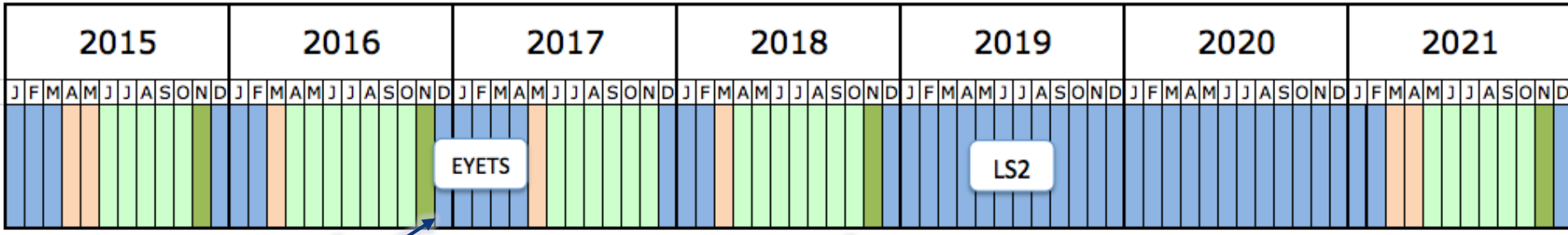
1. Mini test data centre at surface
2. Test & validate DAQ chain





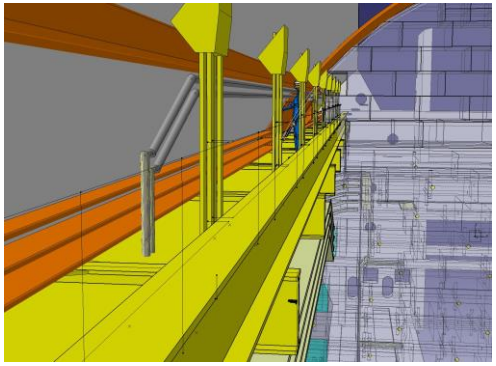
Option: Data Centre at P8 or Prevessin

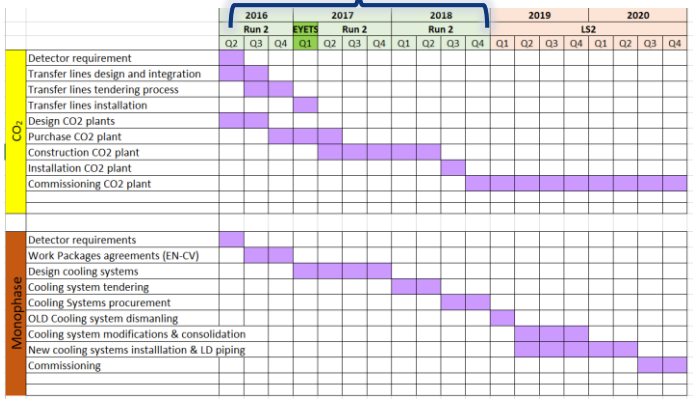
Services

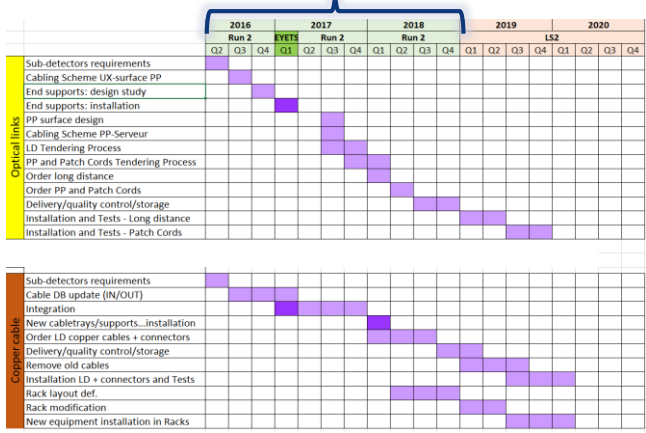


CO2 transfer lines (VELO-UT cooling)

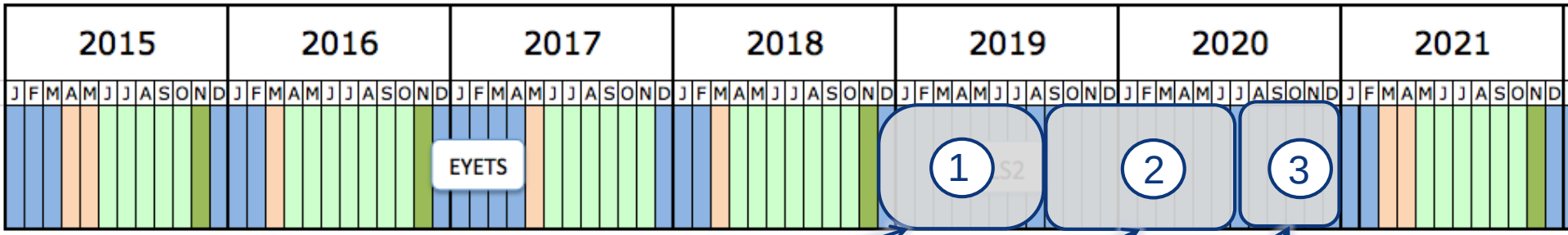
Cooling plants, pipes, optical links, copper cables: specs, design, integration, procurement and installation







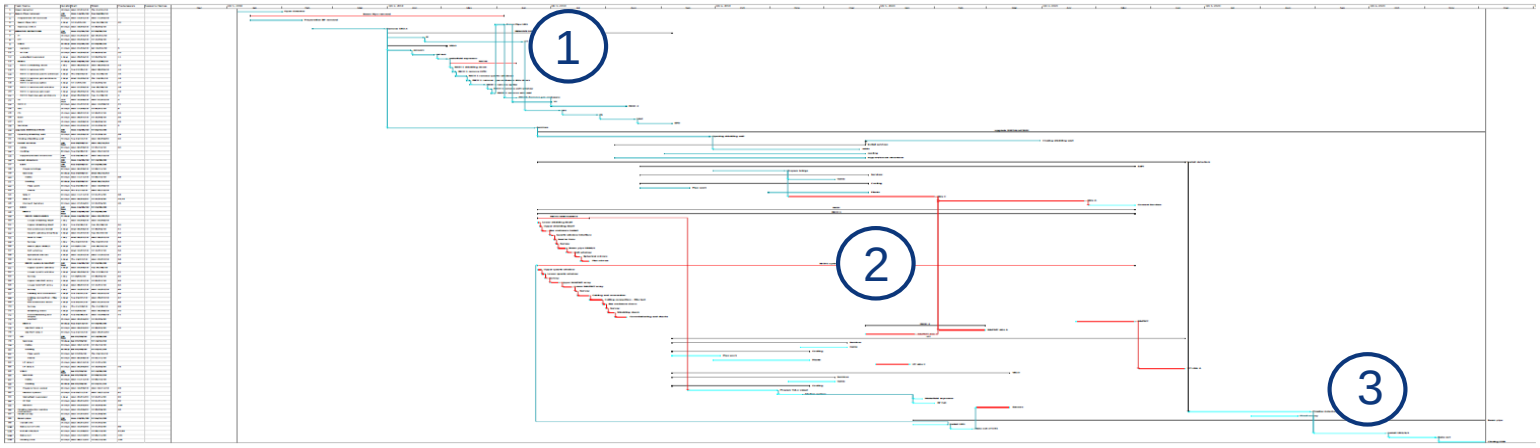
LS2 schedule: 3 phase



Dec19-Aug19
Open Experiment +
Dismantling

Sept19-Jul20
Install detectors
services

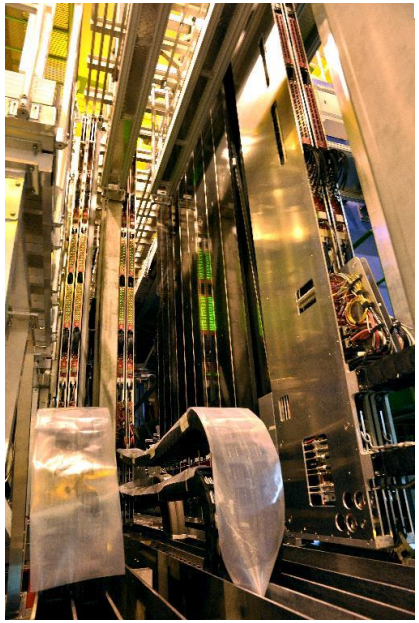
Jul20 Nov20
close Experiment
Survey
Recommissioning



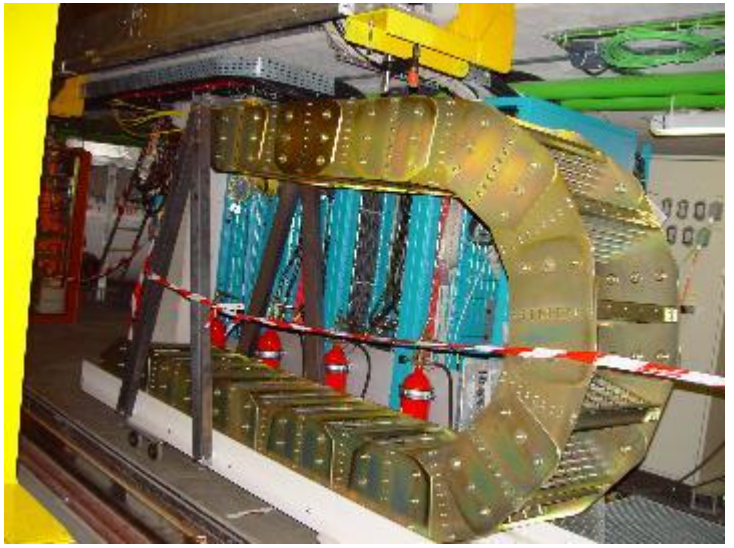
LS2 phase 1: Dismantling / Detectors

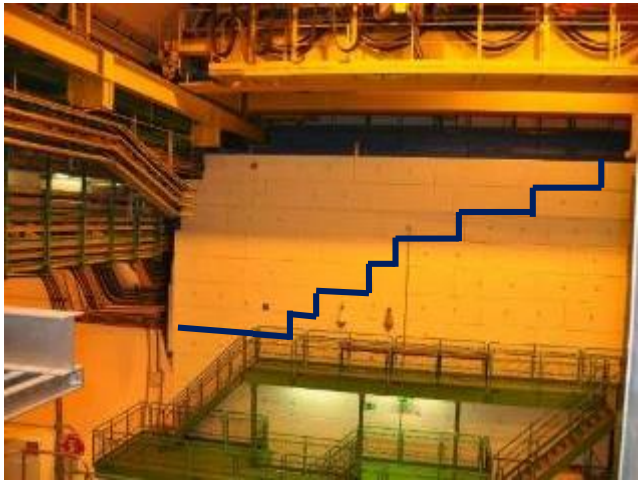
- Open detectors
- Dismantle beam pipe
- Dismantle detectors and services

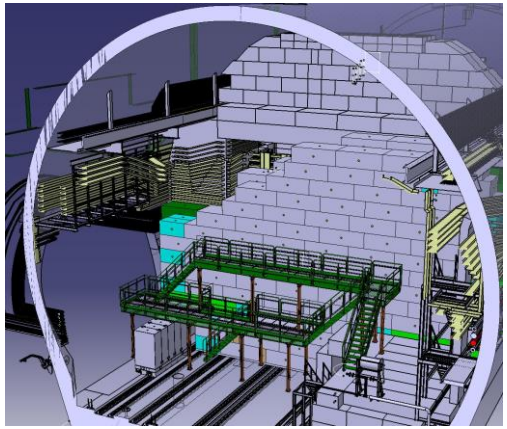
Extra constraints
- Working detector environment
- Radio Protection overhead
  - Protection of personnel – risk assessment prior to any destructive work
  - Logistic – waste sorting – waste disposal



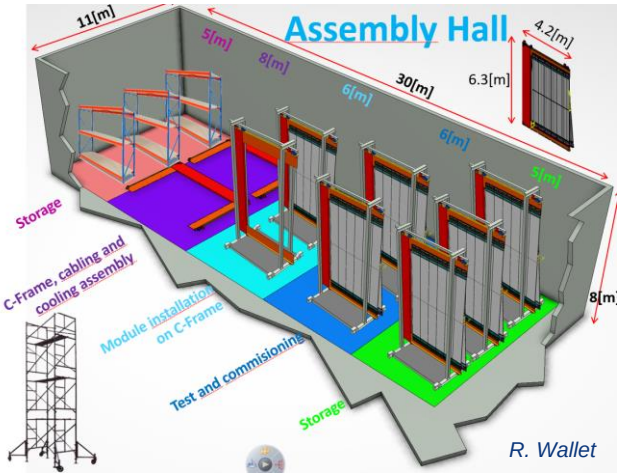
LS2 phase 1: Dismantling / services

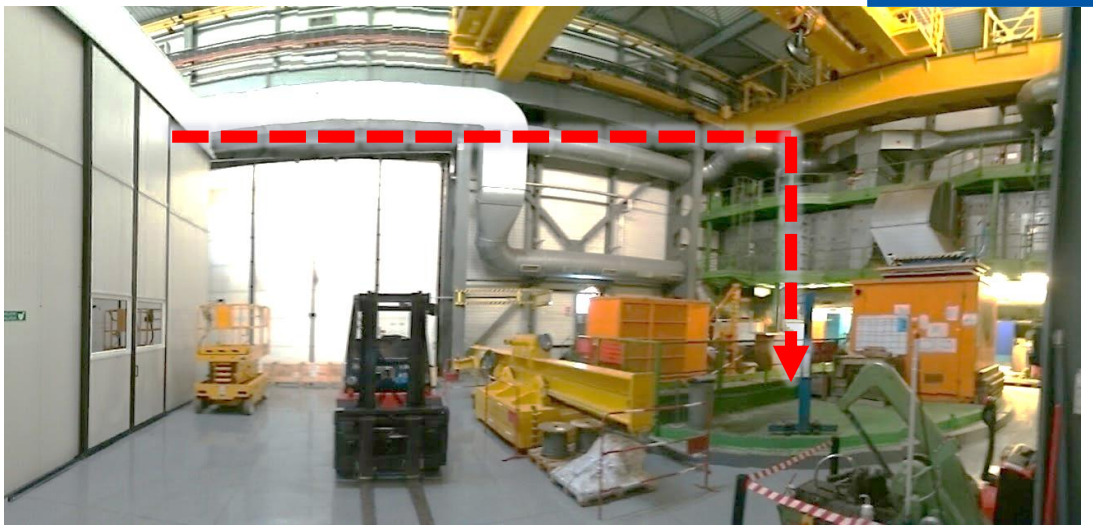




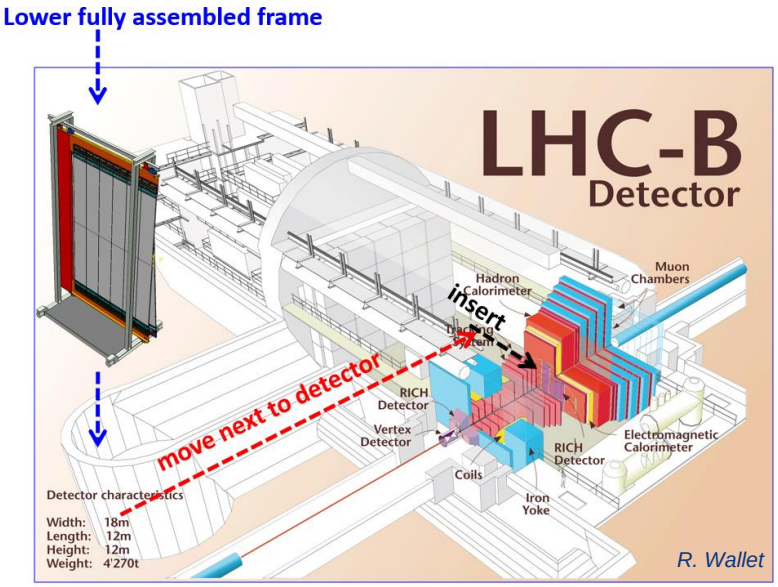


LS2 phase 2: Detectors Installation

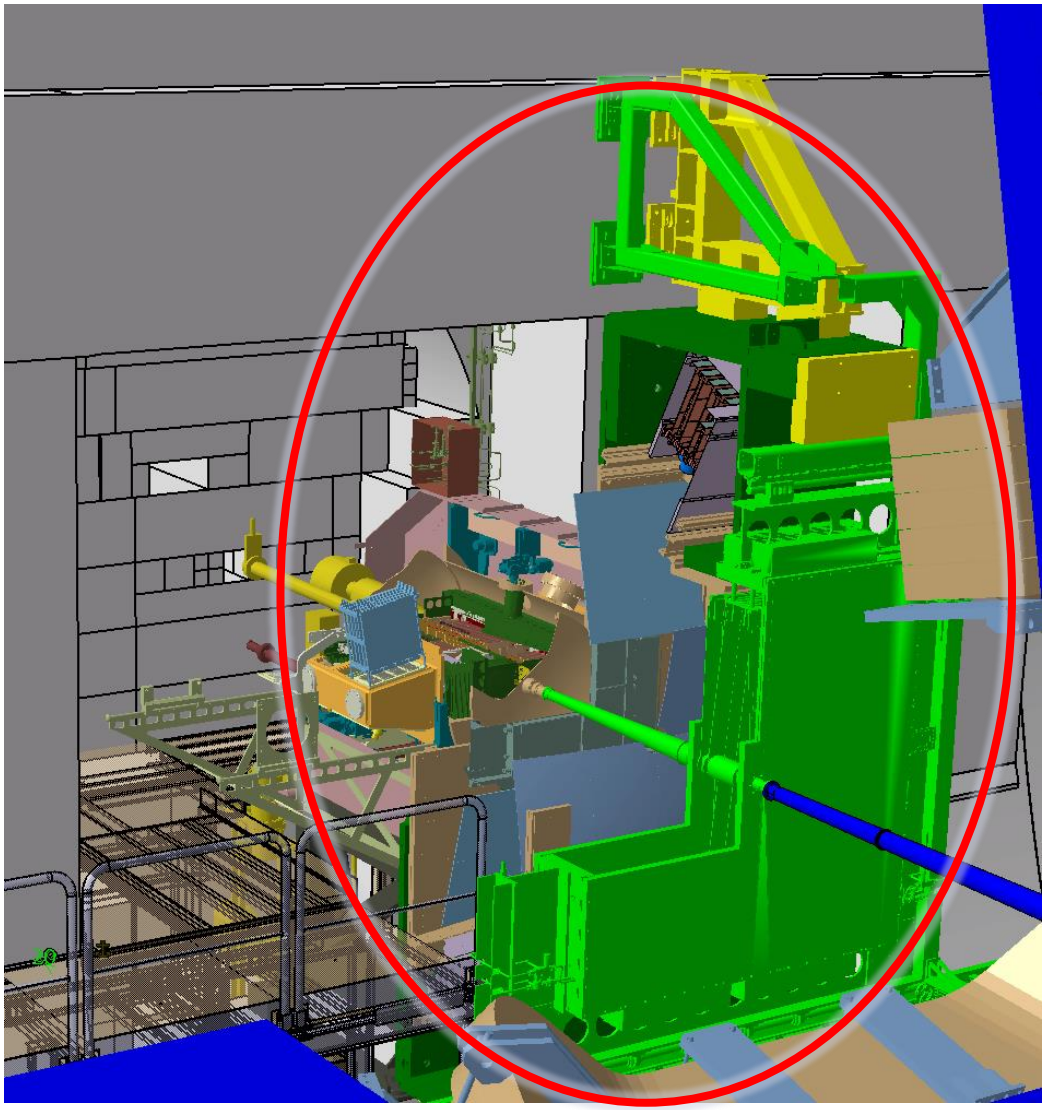


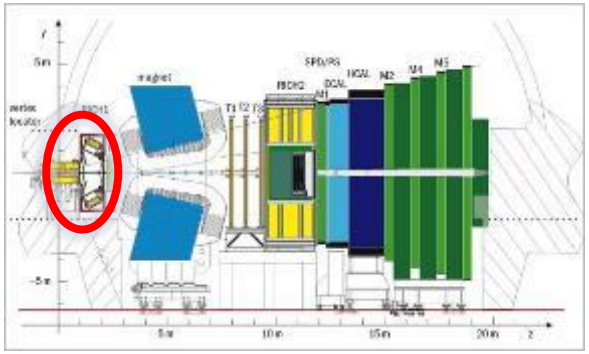


- Detector assembling in surface facilities
- (SciFi, UT, VELO)
- Tests & Survey
- Descent and installation in the pit



LS2 phase 2: Detectors Installation





Most critical path: strong correlations between

- UT
- RICH1
- VELO
- BEAM PIPE

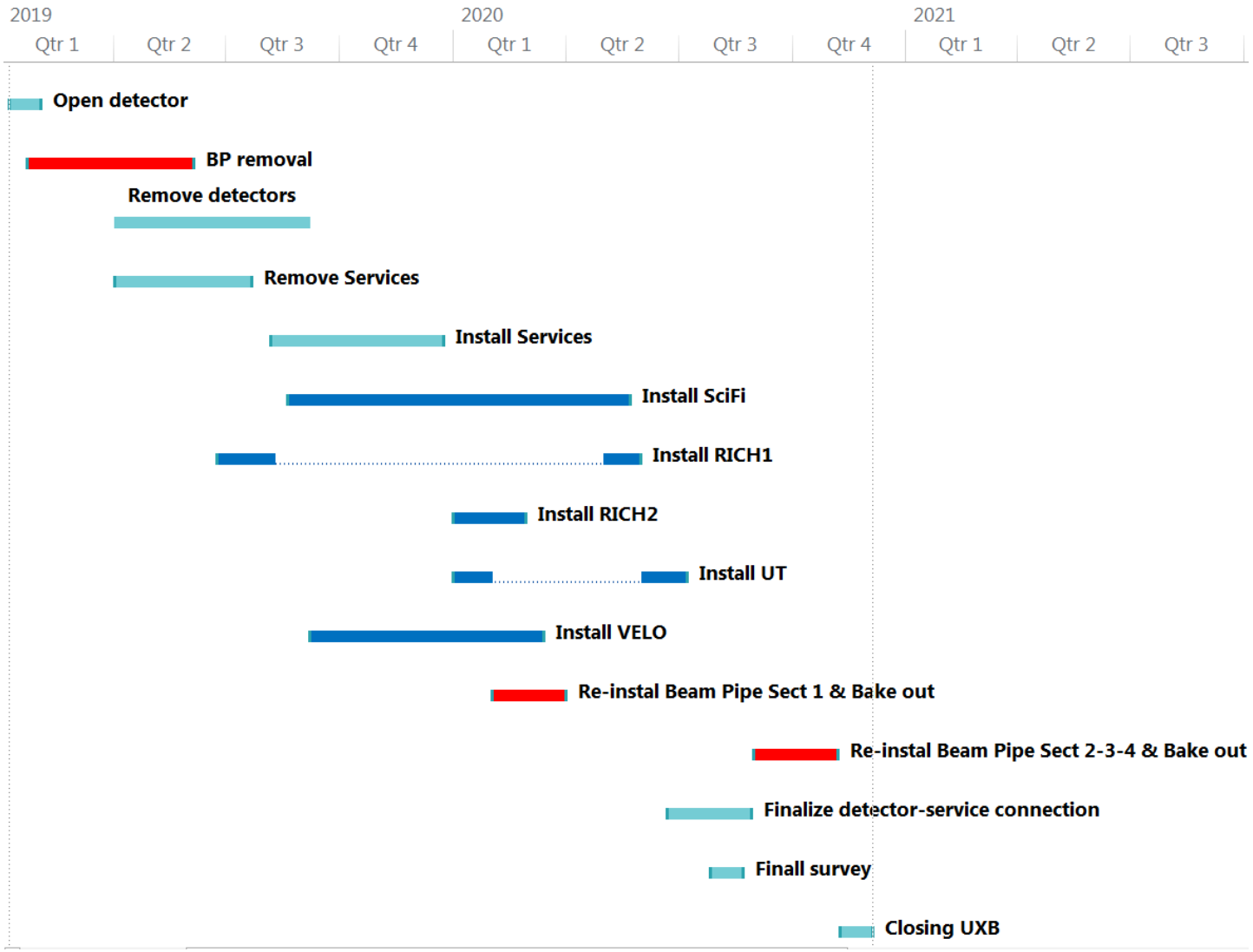
Stringent constraints on installation sequence

Phase 3 Closure & commissioning

- Final connection between detectors and services
- Beam Pipe installation and Bake-out (section 2-4)
- Closing LHCb detectors
- Final survey and alignment of detectors
- Commissioning

Expected end date for Installation work: Nov 2020

Planning: simplified schedule



Conclusion

- Tight schedule
- The current planning does not foresee any contingency
- Delays will be absorbed by shift work or week-ends
- The success relies on strong involvement of participating Institutes and CERN:

EN – Engineering dpt.
- **Survey (detector assembly and positioning)**
- **EL (power, copper cables, optical links)**
- **CV (Detector and Data Center Cooling)**
- **Handling,**
- **Safety Coordination,**
- **EA support**
- **…**

TE – Technology dpt.
- **Vacuum Chamber operation**
- **…**

HSE – Radioprotection
- **Radioprotection**
- **…**